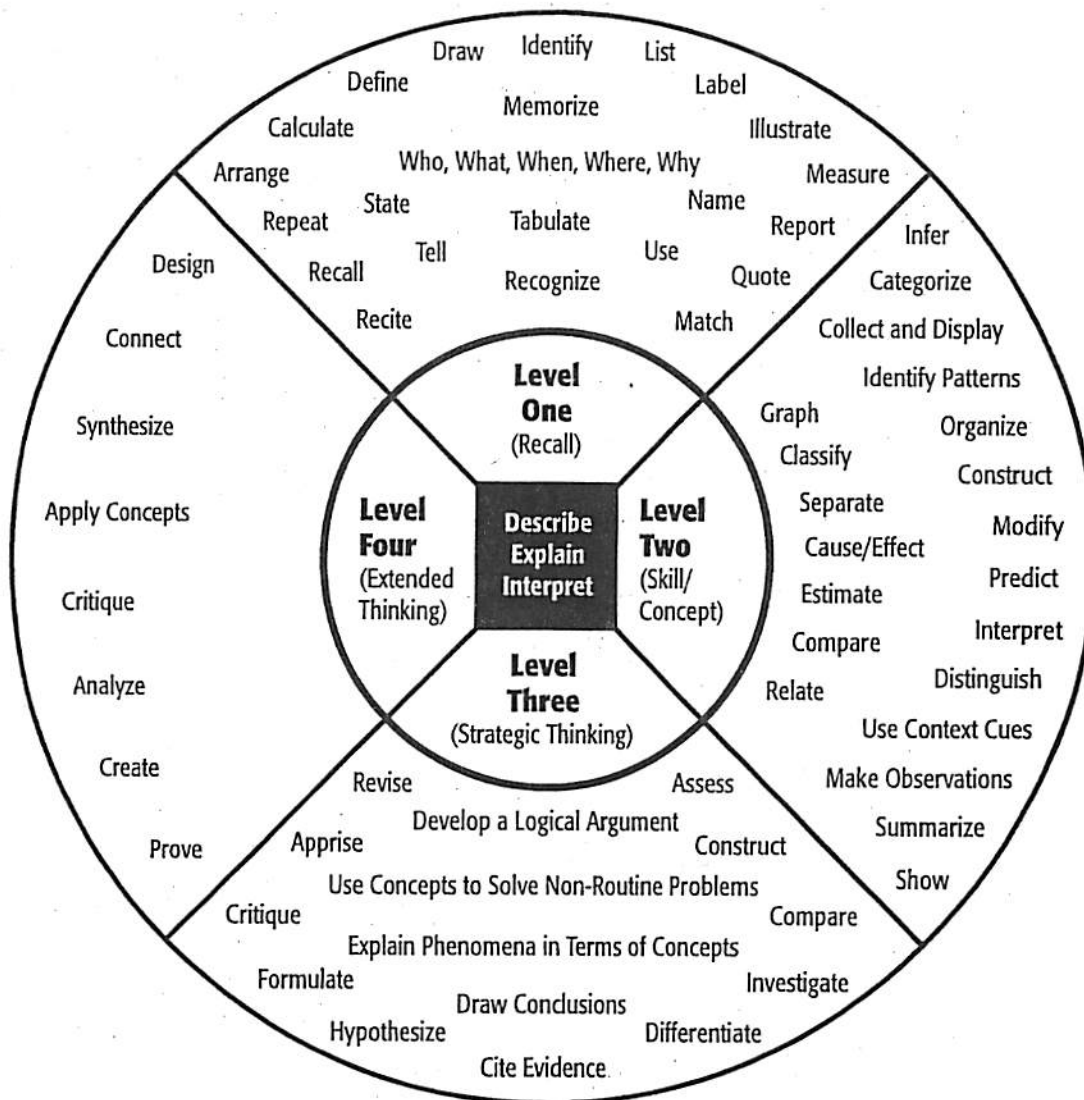


# Depth of Knowledge (DOK) Levels



Level One Activities	Level Two Activities	Level Three Activities	Level Four Activities
<p>Recall elements and details of story structure, such as sequence of events, character, plot and setting.</p> <p>Conduct basic mathematical calculations.</p> <p>Label locations on a map.</p> <p>Represent in words or diagrams a scientific concept or relationship.</p> <p>Perform routine procedures like measuring length or using punctuation marks correctly.</p> <p>Describe the features of a place or people.</p>	<p>Identify and summarize the major events in a narrative.</p> <p>Use context cues to identify the meaning of unfamiliar words.</p> <p>Solve routine multiple-step problems.</p> <p>Describe the cause/effect of a particular event.</p> <p>Identify patterns in events or behavior.</p> <p>Formulate a routine problem given data and conditions.</p> <p>Organize, represent and interpret data.</p>	<p>Support ideas with details and examples.</p> <p>Use voice appropriate to the purpose and audience.</p> <p>Identify research questions and design investigations for a scientific problem.</p> <p>Develop a scientific model for a complex situation.</p> <p>Determine the author's purpose and describe how it affects the interpretation of a reading selection.</p> <p>Apply a concept in other contexts.</p>	<p>Conduct a project that requires specifying a problem, designing and conducting an experiment, analyzing its data, and reporting results/solutions.</p> <p>Apply mathematical model to illuminate a problem or situation.</p> <p>Analyze and synthesize information from multiple sources.</p> <p>Describe and illustrate how common themes are found across texts from different cultures.</p> <p>Design a mathematical model to inform and solve a practical or abstract situation.</p>

Identifying the DOK levels of questions in tests or class assignments can help to articulate how deeply students must understand the related content to complete the necessary tasks. Unlike Bloom's Taxonomy, Webb's model dictates that depth-of-knowledge levels do not necessarily correlate to the commonly understood notion of "difficulty." That is, an activity that aligns to a particular level is not always "easier" than an activity that aligns to a DOK level above it. For example, a DOK-1 activity might ask students to restate a simple fact or a much more abstract theory, the latter being much more difficult to memorize and restate. Neither of these DOK-1 tasks asks for much depth of understanding of the content. On the other hand, greater depth is required to explain how or why a concept or rule works (DOK-2), to apply it to real-world phenomena with justification or supporting evidence (DOK-3), or to integrate a given concept with other concepts or other perspectives (DOK-4).

Interpreting and assigning intended DOK levels to both the standards and the related assessment items are now essential requirements in any alignment analyses. Webb's depth-of-knowledge levels have been applied across all content areas (Hess, 2004, 2005a, 2005b, 2006a, 2006b; Petit & Hess, 2006) and many states and districts utilize the concept of depth of knowledge to designate the depth and complexity of state standards in order to align the state's large-scale assessments or to revise existing standards to achieve higher cognitive levels for instruction. Consequently, teachers need to develop the ability to design instruction, and create units of study/curriculum and classroom assessments for a greater range of cognitive demand.

### **Cognitive Rigor and the CR Matrix**

Although related through their natural ties to the complexity of thought, Bloom's Taxonomy and Webb's depth-of-knowledge differ in scope and application. Bloom's Taxonomy categorizes the cognitive skills required of the brain to perform a task, describing the "type of thinking processes" necessary to answer a question. Depth of knowledge, on the other hand, relates more closely to the depth of content understanding and scope of a learning activity, which manifests in the skills required to complete the task from inception to finale (e.g., planning, researching, drawing conclusions). Both the thinking processes and the depth of content knowledge have direct implications in curricular design, lesson delivery, and assessment development and use.

While there is no simple one-to-one correspondence between these complexity schemas to articulate cognitive rigor, the superposition of Bloom's Taxonomy and Webb's Depth-of-Knowledge Levels was originally expressed in matrix form by Hess (Hess, 2006, 2006b) for use in states where the conversation about cognitive complexity as part of the test design and item development process was just beginning. The CR matrix has been helpful in explaining to teachers how the two conceptual models—Bloom's Taxonomy and Webb's DOK levels—are alike, yet different (Table 2). More importantly, the CR matrix allows educators to examine the depth of understanding required for different tasks that might seem at first glance to be at comparable levels of complexity. Finally, the CR matrix allows educators to uniquely categorize and examine selected assignments/ learning activities that appear prominently in curriculum and instruction. For example, the rote completion of single-step mathematical routines, often derided by the moniker "plug and chug," lies positioned within the (DOK-1, Bloom-3) or the (1,3) cell of the CR matrix. Using the CR matrix to plot typical mathematics assignments from a unit of study, a teacher might discover to what extent this level of cognitive rigor is being assessed compared to (DOK-3, Bloom-3) or the (3,3) cell of the CR matrix, using strategic

thinking/reasoning (DOK-3) and application (Bloom-3). When used to plot multiple assignments over time, the CR matrix can graphically display a unique view of instructional emphasis and ultimately reveal the focus of learning within a classroom, a grade level, or a school system.

# Hess' Cognitive Rigor Matrix: Applies Webb's DOK to Bloom's Cognitive Process Dimensions

<b>Depth + thinking</b>	<b>Level 1 Recall &amp; Reproduction</b>	<b>Level 2 Basic Skills &amp; Concepts</b>	<b>Level 3 Strategic Thinking &amp; Reasoning</b>	<b>Level 4 Extended Thinking</b>
<b>Remember</b>	- Recall, locate basic facts, details, events			
<b>Understand</b>	- Select appropriate words to use when intended meaning is clearly evident	- Specify, explain relationships - summarize - Identify main ideas	- Explain, generalize, or connect ideas using supporting evidence (quote, example...)	- Explain how concepts or ideas specifically relate to other content domains or concepts
<b>Apply</b>	- Use language structure (pre/suffix) or word relationships (synonym/antonym) to determine meaning	- Use context to identify meaning of word - Obtain and Interpret Information using text features	- Use concepts to solve non-routine problems	- Devise an approach among many alternatives to research a novel problem
<b>Analyze</b>	- Identify whether information is contained in a graph, table, etc.	- Compare literary elements, terms, facts, events - analyze format, organization, & text structures	- Analyze or interpret author's craft (literary devices, viewpoint, or potential bias) to critique a text	- Analyze multiple sources or texts - Analyze complex/abstract themes
<b>Evaluate</b>			- Cite evidence and develop a logical argument for conjectures	- Evaluate relevancy, accuracy, & completeness of information
<b>Create</b>	- Brainstorm ideas about a topic	- Generate conjectures based on observations or prior knowledge	- Synthesize information within one source or text	- Synthesize information across multiple sources or texts

**Hess' Cognitive Rigor Matrix & Curricular Examples: Applying Webb's Depth-of-Knowledge Levels to Bloom's Cognitive Process Dimensions - ELA**

<b>Revised Bloom's Taxonomy</b>	<b>Webb's DOK Level 1 Recall &amp; Reproduction</b>	<b>Webb's DOK Level 2 Skills &amp; Concepts</b>	<b>Webb's DOK Level 3 Strategic Thinking/ Reasoning</b>	<b>Webb's DOK Level 4 Extended Thinking</b>
<b>Remember</b> Retrieve knowledge from long-term memory, recognize, recall, locate, identify	<ul style="list-style-type: none"> <li>Recall, recognize, or locate basic facts, details, events, or ideas explicit in texts</li> <li>Read words orally in connected text with fluency &amp; accuracy</li> </ul>			
<b>Understand</b> Construct meaning, clarify, paraphrase, represent, translate, illustrate, give examples, classify, categorize, summarize, generalize, infer a logical conclusion, predict, compare/contrast, match like ideas, explain, construct models	<ul style="list-style-type: none"> <li>Identify or describe literary elements (characters, setting, sequence, etc.)</li> <li>Select appropriate words when intended meaning/definition is clearly evident</li> <li>Describe/explain who, what, where, when, or how</li> <li>Define/describe facts, details, terms, principles</li> <li>Write simple sentences</li> </ul>	<ul style="list-style-type: none"> <li>Specify, explain, show relationships; explain why, cause-effect</li> <li>Give non-examples/examples</li> <li>Summarize results, concepts, ideas</li> <li>Make basic inferences or logical predictions from data or texts</li> <li>Identify main ideas or accurate generalizations of texts</li> <li>Locate information to support explicit/implicit central ideas</li> </ul>	<ul style="list-style-type: none"> <li>Explain, generalize, or connect ideas using supporting evidence (quote, example, text reference)</li> <li>Identify/ make inferences about explicit or implicit themes</li> <li>Describe how word choice, point of view, or bias may affect the readers' interpretation of a text</li> <li>Write multi-paragraph composition for specific purpose, focus, voice, tone, &amp; audience</li> </ul>	<ul style="list-style-type: none"> <li>Explain how concepts or ideas specifically relate to <i>other</i> content domains or concepts</li> <li>Develop generalizations of the results obtained or strategies used and apply them to new problem situations</li> </ul>
<b>Apply</b> Carry out or use a procedure in a given situation; carry out (apply to a familiar task), or use (apply) to an unfamiliar task	<ul style="list-style-type: none"> <li>Use language structure (pre/suffix) or word relationships (synonym/antonym) to determine meaning of words</li> <li>Apply rules or resources to edit spelling, grammar, punctuation, conventions, word use</li> <li>Apply basic formats for documenting sources</li> </ul>	<ul style="list-style-type: none"> <li>Use context to identify the meaning of words/phrases</li> <li>Obtain and interpret information using text features</li> <li>Develop a text that may be limited to one paragraph</li> <li>Apply simple organizational structures (paragraph, sentence types) in writing</li> </ul>	<ul style="list-style-type: none"> <li>Apply a concept in a new context</li> <li>Revise final draft for meaning or progression of ideas</li> <li>Apply internal consistency of text organization and structure to composing a full composition</li> <li>Apply word choice, point of view, style to impact readers' /viewers' interpretation of a text</li> </ul>	<ul style="list-style-type: none"> <li>Illustrate how multiple themes (historical, geographic, social) may be interrelated</li> <li>Select or devise an approach among many alternatives to research a novel problem</li> </ul>
<b>Analyze</b> Break into constituent parts, determine how parts relate, differentiate between relevant-irrelevant, distinguish, focus, select, organize, outline, find coherence, deconstruct (e.g., for bias or point of view)	<ul style="list-style-type: none"> <li>Identify whether specific information is contained in graphic representations (e.g., map, chart, table, graph, T-chart, diagram) or text features (e.g., headings, subheadings, captions)</li> <li>Decide which text structure is appropriate to audience and purpose</li> </ul>	<ul style="list-style-type: none"> <li>Categorize/compare literary elements, terms, facts/details, events</li> <li>Identify use of literary devices</li> <li>Analyze format, organization, &amp; internal text structure (signal words, transitions, semantic cues) of different texts</li> <li>Distinguish: relevant-irrelevant information; fact/opinion</li> <li>Identify characteristic text features; distinguish between texts, genres</li> </ul>	<ul style="list-style-type: none"> <li>Analyze information within data sets or texts</li> <li>Analyze interrelationships among concepts, issues, problems</li> <li>Analyze or interpret author's craft (literary devices, viewpoint, or potential bias) to create or critique a text</li> <li>Use reasoning, planning, and evidence to support inferences</li> </ul>	<ul style="list-style-type: none"> <li>Analyze multiple sources of evidence, or multiple works by the same author, or across genres, time periods, themes</li> <li>Analyze complex/abstract themes, perspectives, concepts</li> <li>Gather, analyze, and organize multiple information sources</li> <li>Analyze discourse styles</li> </ul>
<b>Evaluate</b> Make judgments based on criteria, check, detect inconsistencies or fallacies, judge, critique			<ul style="list-style-type: none"> <li>Cite evidence and develop a logical argument for conjectures</li> <li>Describe, compare, and contrast solution methods</li> <li>Verify reasonableness of results</li> <li>Justify or critique conclusions drawn</li> </ul>	<ul style="list-style-type: none"> <li>Evaluate relevancy, accuracy, &amp; completeness of information from multiple sources</li> <li>Apply understanding in a novel way, provide argument or justification for the application</li> </ul>
<b>Create</b> Reorganize elements into new patterns/structures, generate, hypothesize, design, plan, produce	Brainstorm ideas, concepts, problems, or perspectives related to a topic or concept	<ul style="list-style-type: none"> <li>Generate conjectures or hypotheses based on observations or prior knowledge and experience</li> </ul>	<ul style="list-style-type: none"> <li>Synthesize information within one source or text</li> <li>Develop a complex model for a given situation</li> <li>Develop an alternative solution</li> </ul>	<ul style="list-style-type: none"> <li>Synthesize information across multiple sources or texts</li> <li>Articulate a new voice, alternate theme, new knowledge or perspective</li> </ul>

# Webb's Depth-of-Knowledge Levels

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- **DOK-1 – Recall & Reproduction** - Recall of a fact, term, principle, concept; perform a routine procedure; locate details
- **DOK-2 – Basic Application of Skills/Concepts** - Use of information; conceptual knowledge; select appropriate procedures for a given task; two or more steps with decision points along the way; routine problems; organize/display data; interpret/use simple graphs; summarize; identify main idea; explain relationships; make predictions
- **DOK-3 – Strategic Thinking** - Requires reasoning, or developing a plan or sequence of steps to approach problem; requires decision making or justification; abstract, complex, or non-routine; often more than one possible answer; support solutions or judgments with text evidence
- **DOK-4 – Extended Thinking** - An investigation or application to real world; requires time to research, problem solve, and process multiple conditions of the problem or task; non-routine manipulations; synthesize information across disciplines/content areas/multiple sources

## **Reading DOK Levels**

### ***Reading Level 1.***

Level 1 requires students to receive or recite facts or to use simple skills or abilities. Oral reading that does not include analysis of the text, as well as basic comprehension of a text, is included. Items require only a shallow understanding of the text presented and often consist of verbatim recall from text, slight paraphrasing of specific details from the text, or simple understanding of a single word or phrase. Some examples that represent, but do not constitute all of, Level 1 performance are:

- Support ideas by reference to verbatim or only slightly paraphrased details from the text.
- Use a dictionary to find the meanings of words.
- Recognize figurative language in a reading passage.

### ***Reading Level 2.***

Level 2 includes the engagement of some mental processing beyond recalling or reproducing a response; it requires both comprehension and subsequent processing of text or portions of text. Inter-sentence analysis of inference is required. Some important concepts are covered, but not in a complex way. Standards and items at this level may include words such as summarize, interpret, infer, classify, organize, collect, display, compare, and determine whether fact or opinion. Literal main ideas are stressed. A Level 2 assessment item may require students to apply skills and concepts that are covered in Level 1. However, items require closer understanding of text, possibly through the item's paraphrasing of both the question and the answer.

Some examples that represent, but do not constitute all of, Level 2 performance are:

- Use context cues to identify the meaning of unfamiliar words, phrases, and expressions that could otherwise have multiple meanings.
- Predict a logical outcome based on information in a reading selection.
- Identify and summarize the major events in a narrative.

### ***Reading Level 3.***

Deep knowledge becomes a greater focus at Level 3. Students are encouraged to go beyond the text; however, they are still required to show understanding of the ideas in the text. Students may be encouraged to explain, generalize, or connect ideas. Standards and items at Level 3 involve reasoning and planning. Students must be able to support their thinking. Items may involve abstract theme identification, inference across an entire passage, or students' application of prior knowledge. Items may also involve more superficial connections between texts.

Some examples that represent, but do not constitute all of, Level 3 performance are:

- Explain or recognize how the author's purpose affects the interpretation of a reading selection.
- Summarize information from multiple sources to address a specific topic.
- Analyze and describe the characteristics of various types of literature.

### ***Reading Level 4.***

Higher-order thinking is central and knowledge is deep at Level 4. The standard or assessment item at this level will probably be an extended activity, with extended time provided for completing it. The extended time period is not a distinguishing factor if the required work is only repetitive and does not require the application of significant conceptual understanding and higher-order thinking.

Students take information from at least one passage of a text and are asked to apply this information to a new task. They may also be asked to develop hypotheses and perform complex analyses of the connections among texts.

Some examples that represent, but do not constitute all of, Level 4 performance are:

- Analyze and synthesize information from multiple sources.
- Examine and explain alternative perspectives across a variety of sources.
- Describe and illustrate how common themes are found across texts from different cultures.



**Table 1: Sample Depth-of-Knowledge Level Descriptors for Reading**  
(Based on Webb and Wixson, K. Hess, Center for Assessment/NCIEA, 2004)

<b>Level 1</b> <b>Recall of Information</b>	<b>Level 2</b> <b>Basic Reasoning</b>	<b>Level 3</b> <b>Complex Reasoning</b>	<b>Level 4</b> <b>Extended Reasoning</b>
<ul style="list-style-type: none"> <li>a. Read words orally in isolation</li> <li>b. Read words orally in connected text</li> <li>c. Read multi-syllabic words</li> <li>d. Locate or recall facts or details explicitly presented in text</li> <li>e. Identify or describe characters, setting, sequence of events</li> <li>f. Use language structure (pre/suffix) or word relationships (synonym/antonym) to determine meaning of words</li> <li>g. Select appropriate words to use in context (e.g., content-specific words, shades of meaning) when intended meaning is clearly evident</li> </ul>	<ul style="list-style-type: none"> <li>a. Use context cues or resources to identify the meaning of unfamiliar words</li> <li>b. Predict a logical outcome based on information in a reading selection</li> <li>c. Make basic inferences or draw basic conclusions about information presented in text (e.g., According to this report, what caused ___?)</li> <li>d. Recognizing appropriate generalizations about text (e.g., possible titles, main ideas)</li> <li>e. Identify and summarize the major events, problem, solution, conflicts in a literary text</li> <li>f. Determine whether a text is fact or fiction</li> <li>g. Distinguish between fact and opinion</li> <li>h. Describe the characteristics or features of various types of text</li> <li>i. Obtain information using text features of informational text (e.g., Table of Contents, sidebar, chart)</li> <li>j. Organize information presented in informational text using mapping, charting, or summarizing</li> <li>k. Locate information to answer questions related to explicit or implicit central ideas in informational texts</li> <li>l. Identify use of literary devices (e.g., imagery, idioms, exaggeration, alliteration, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>a. Explain, generalize, or connect ideas, using supporting evidence from the text or from other sources</li> <li>b. Draw inferences about author's purpose, author's message or theme (explicit or implied)</li> <li>c. Make and support inferences about implied causes and effects</li> <li>d. Describe how word choice, point of view, or bias affects the interpretation of a reading selection</li> <li>e. Summarize or compare information within and across text passages</li> <li>f. Analyze interrelationships among elements of the text (plot, subplots, characters, setting)</li> <li>g. Analyze or interpret use of author's craft (literary devices) to analyze or critique a literary text</li> </ul>	<ul style="list-style-type: none"> <li>a. Compare or analyze multiple works by the same author, including author's craft</li> <li>b. Compare or analyze multiple works from the same time period or from the same genre</li> <li>c. Gather, analyze, organize, and interpret information from multiple (print and non print) sources for the purpose of drafting a reasoned report</li> <li>d. Evaluate the relevancy and accuracy of information from multiple (print and non print) sources (e.g., verifying factual information or assertions with other sources; researching the source of information)</li> </ul>



What exactly do “fewer, clearer, and higher standards” really look like in the classroom? Using a cognitive rigor matrix to analyze curriculum, plan lessons, and implement assessments

Karin K. Hess, Dennis Carlock, Ben Jones, and John R. Walkup

Abstract

With the ever-increasing call for more rigorous curriculum, instruction, and assessment in the United States, the National Governors Association and the Council of Chief State School Officers are aiming to define the rigorous skills and knowledge that students need in order to succeed academically in college-entry courses and in workforce training programs (Glod, 2009). The proposed Common Core Standards will require high-level cognitive demand, such as asking students to demonstrate deep conceptual understanding through the application of content knowledge and skills to new situations. Using two widely accepted measures of describing cognitive rigor — Bloom's Taxonomy of Educational Objectives and Webb's Depth-of-Knowledge Levels — this article defines cognitive rigor and presents a matrix that integrates these models as a strategy for analyzing instruction and influencing teacher lesson planning. Using Hess' Cognitive Rigor Matrix (CRM), a density plot illustrates how the preponderance of curricular items (e.g., assignment questions and problem solving tasks) might align to cells in the matrix. Research results applying the matrix in two states' large-scale collection of student work samples are presented, along with a discussion of implications for curriculum planning in order to cultivate twenty-first century skills.

Beginning with Bloom

In 1956, a group of educational psychologists headed by Benjamin Bloom developed a classification of levels of intellectual behavior important in learning. Bloom created this taxonomy for categorizing the levels of abstraction of questions that commonly occur in educational settings. Using these levels for analysis, Bloom found that over 95% of test questions students encounter at the college level required them to think only at the lowest possible level: the recall of information. Bloom's committee identified three domains of educational activities: cognitive (*knowledge*), affective (*attitude*), and psychomotor (*skills*). Within the cognitive domain, which is tied directly to mental skills, Bloom identified a hierarchy of six levels that increased in complexity and abstraction — from the simple recall of facts, *knowledge*, to the highest order of thinking, *evaluation*. In practice, educators assigned Bloom's Taxonomy levels according to the main action verb associated with a level in the taxonomy. For example, examining the meaning of a metaphor and categorizing geometric shapes would both align to Bloom's Taxonomy, *Analysis* level. While educators have found such verb cues of Bloom's Taxonomy levels to be useful in guiding teacher questioning, verbs often appear at more than one level in the taxonomy (e.g., *appraise, compare, explain, select, write*); and often the verb alone is inadequate for determining the actual cognitive demand required to understand the content addressed in a test question or learning activity. (See Table 1.)

Building upon Bloom's early work, many educational and cognitive psychologists have since developed various schemas to describe the cognitive demand for different learning and assessment contexts. In 2001, Anderson, Krathwohl, et al. presented a structure for rethinking Bloom's Taxonomy. Whereas the original taxonomy possessed one dimension, the revised taxonomy table applied two

dimensions—cognitive processes *and* knowledge. The cognitive processes resemble those found in the original taxonomy, but placement on the taxonomy continuum has changed slightly (e.g., evaluation no longer resides at the highest level) and descriptions have been expanded and better differentiated for analyzing educational objectives. The revised descriptors consider both the processes (the verbs) and the knowledge (the nouns) used to articulate educational objectives. This restructuring of the original taxonomy recognizes the importance of the interaction between the content taught — characterized by factual, conceptual, procedural, and metacognitive knowledge — and the thought processes used to demonstrate learning.

Table 1: A Comparison of Descriptors: Bloom's Original Taxonomy and the Revised Bloom's Taxonomy Cognitive Process Dimensions	
Bloom's Taxonomy (1956)	The Revised Bloom Process Dimensions (2005)
<b>Knowledge</b> Define, duplicate, label, list, memorize, name, order, recognize, relate, recall, reproduce, state	<b>Remember</b> Retrieve knowledge from long-term memory, recognize, recall, locate, identify
<b>Comprehension</b> Classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate	<b>Understand</b> Construct meaning, clarify, paraphrase, represent, translate, illustrate, give examples, classify, categorize, summarize, generalize, infer a logical conclusion (such as from examples given), predict, compare/contrast, match like ideas, explain, construct models (e.g., cause-effect)
<b>Application</b> Apply, choose, demonstrate, dramatize, employ, illustrate, interpret, practice, schedule, sketch, solve, use, write	<b>Apply</b> Carry out or use a procedure in a given situation; carry out (apply to a familiar task), or use (apply) to an unfamiliar task
<b>Analysis</b> Analyze, appraise, calculate, categorize, compare, criticize, discriminate, distinguish, examine, experiment, explain	<b>Analyze</b> Break into constituent parts, determine how parts relate, differentiate between relevant-irrelevant, distinguish, focus, select, organize, outline, find coherence, deconstruct (e.g., for bias or point of view)
<b>Synthesis</b> Rearrange, assemble, collect, compose, create, design, develop, formulate, manage, organize, plan, propose, set up, write	<b>Evaluate</b> Make judgments based on criteria, check, detect inconsistencies or fallacies, judge, critique
<b>Evaluation</b> Appraise, argue, assess, choose, compare, defend, estimate, explain, judge, predict, rate, core, select, support, value, evaluate	<b>Create</b> Put elements together to form a coherent whole, reorganize elements into new patterns/structures, generate, hypothesize, design, plan, construct, produce for a specific purpose

### Webb's Depth-of-Knowledge (DOK) Levels

Depth of knowledge forms another important perspective of cognitive complexity. Probably the best-known work in the area of depth of knowledge is that of Norman Webb (1997, 1999). Webb's work has forced states to rethink the meaning of test alignment to include both the content assessed in a test item and the intended cognitive demand, or the depth to which we expect students to demonstrate understanding of that content. In other words, the complexity of both the content (e.g., simple vs. complex data displays; interpreting literal vs. figurative language) and the task required (e.g., solving routine vs. non-routine problems) are used to determine DOK levels. Webb describes his depth-of-knowledge levels as "nominative" rather than as a taxonomy, meaning that DOK levels name (or describe) four different and deeper ways a student might interact with content (2002).

Webb's Depth-of-Knowledge Levels	
<b>DOK-1 – Recall &amp; Reproduction</b>	Recall of a fact, term, principle, concept, or perform a routine procedure
<b>DOK-2 – Basic Application of Skills/Concepts</b>	Use of information, conceptual knowledge, select appropriate procedures for a task, two or more steps with decision points along the way, routine problems, organize/display data, interpret/use simple graphs
<b>DOK-3 – Strategic Thinking</b>	Requires reasoning, developing a plan or sequence of steps to approach problem; requires some decision making and justification; abstract, complex, or non-routine; often more than one possible answer
<b>DOK-4 – Extended Thinking</b>	An investigation or application to real world; requires time to research, problem solve, and process multiple conditions of the problem or task; non-routine manipulations, across disciplines/content areas/multiple sources

Identifying the DOK levels of questions in tests or class assignments can help to articulate how deeply students must understand the related content to complete the necessary tasks. Unlike Bloom's Taxonomy, Webb's model dictates that depth-of-knowledge levels do not necessarily correlate to the commonly understood notion of "difficulty." That is, an activity that aligns to a particular level is not always "easier" than an activity that aligns to a DOK level above it. For example, a DOK-1 activity might ask students to restate a simple fact or a much more abstract theory, the latter being much more difficult to memorize and restate. Neither of these DOK-1 tasks asks for much depth of understanding of the content. On the other hand, greater depth is required to explain how or why a concept or rule works (DOK-2), to apply it to real-world phenomena with justification or supporting evidence (DOK-3), or to integrate a given concept with other concepts or other perspectives (DOK-4).

Interpreting and assigning intended DOK levels to both the standards and the related assessment items are now essential requirements in any alignment analyses. Webb's depth-of-knowledge levels have been applied across all content areas (Hess, 2004, 2005a, 2005b, 2006a, 2006b; Petit & Hess, 2006) and many states and districts utilize the concept of depth of knowledge to designate the depth and complexity of state standards in order to align the state's large-scale assessments or to revise existing standards to achieve higher cognitive levels for instruction. Consequently, teachers need to develop the ability to design instruction, and create units of study/curriculum and classroom assessments for a greater range of cognitive demand.

### **Cognitive Rigor and the CR Matrix**

Although related through their natural ties to the complexity of thought, Bloom's Taxonomy and Webb's depth-of-knowledge differ in scope and application. Bloom's Taxonomy categorizes the cognitive skills required of the brain to perform a task, describing the "type of thinking processes" necessary to answer a question. Depth of knowledge, on the other hand, relates more closely to the depth of content understanding and scope of a learning activity, which manifests in the skills required to complete the task from inception to finale (e.g., planning, researching, drawing conclusions). Both the thinking processes and the depth of content knowledge have direct implications in curricular design, lesson delivery, and assessment development and use.

While there is no simple one-to-one correspondence between these complexity schemas to articulate cognitive rigor, the superposition of Bloom's Taxonomy and Webb's Depth-of-Knowledge Levels was originally expressed in matrix form by Hess (Hess, 2006, 2006b) for use in states where the conversation about cognitive complexity as part of the test design and item development process was just beginning. The CR matrix has been helpful in explaining to teachers how the two conceptual models—Bloom's Taxonomy and Webb's DOK levels—are alike, yet different (Table 2). More importantly, the CR matrix allows educators to examine the depth of understanding required for different tasks that might seem at first glance to be at comparable levels of complexity. Finally, the CR matrix allows educators to uniquely categorize and examine selected assignments/ learning activities that appear prominently in curriculum and instruction. For example, the rote completion of single-step mathematical routines, often derided by the moniker "plug and chug," lies positioned within the (DOK-1, Bloom-3) or the (1,3) cell of the CR matrix. Using the CR matrix to plot typical mathematics assignments from a unit of study, a teacher might discover to what extent this level of cognitive rigor is being assessed compared to (DOK-3, Bloom-3) or the (3,3) cell of the CR matrix, using strategic

thinking/reasoning (DOK-3) and application (Bloom-3). When used to plot multiple assignments over time, the CR matrix can graphically display a unique view of instructional emphasis and ultimately reveal the focus of learning within a classroom, a grade level, or a school system.